WHY ARE THERE SO MANY BUMBLEBEES SPECIES IN EYNE (FRANCE, PYRÉNÉES-ORIENTALES, CERDAGNE)?

P. Rasmont, E.-A. Durieux, S. Iserbyt & M. Baracetti

SUMMARY

With 32 species of bumblebees found in an area of 2000ha, the commune of Eyne may be the most diversified place in West-Palaearctic, perhaps also in the whole world. The authors discuss shortly some hypotheses to explain this high specific richness. Within the same commune, the biogeographical and ecological conditions are extremely diverse. However, the number of species is obviously too high to fit the rules of resource sharing. The authors suggest that the well known Pyrenean climatic instability brings about a high, random non specific mortality. This factor, linked with a very high floral diversity and abundance, could reduce inter- and intra-specific competition, leading to the coexistence of a large number of species.

INTRODUCTION

The origin of bumblebee diversity has been often discussed. The most extreme view in this field has been held by Inouye (1977a, 1977b, 1978). His tempting but misleading simplification has been challenged by Ranta & Vepsäläinen (1981) who noted that in the tundra and the taiga of northern Fennoscandia, up to twelve species may coexist. Hanski (1982) modulated the theory of Inouye by considering that interspecific competition for resources plays a major role in the occurrence of the most abundant species only. Hanski calls these dominant species, the "core" species, each of them accounting for more than 3 % of the total bumblebee population. In his view, the "satellite" species - i. e. those accounting for less than 3 % - would be a mere "random combination of the regional species pool".

According to Rasmont (1989), these conceptions of Inouye and Hanski may not apply to the bumblebee fauna of some locations in France, where the local species diversity, as well as the number of "core" species largely exceeds their predictions. The most species-rich regions in France

are the Causse du Larzac (around 43°59'N 3°10'E) and the Cerdagne (around 42°32'N 2°08'E).

The present communication is about the commune of Eyne (Fig. 1), in Cerdagne, where the greatest diversity of bumblebees has been recorded. We shall endeavour some hypotheses about the origin of this diversity.

MATERIAL & METHODS

The first author has compiled the records of all the specimens originating from this region and already available in collections (Tab. I). He has also repeatedly explored the region. The present sample covering of the department of Pyrénées-Orientales is sufficient to permit valid faunistic considerations (fig. 2).

Table I. *Main recorders for the bumblebees (Apidae, Bombinae) from Pyrénées-Orientales.*

Recorders	specimens numbers	Recorders	specimens numbers
R. Delmas	4958	A. Foucart	5
P. Rasmont	1324	Khochbaf	4
F. Leclant	602	R. De Jonghe	3
I.H.H. Yarrow	579	Isbecque	3
J. Hamon	100	R. Aspock	2
T. Moreau	86	Bourgeois	2
Picard	62	Lesne	2
A. Scholl	60	J. Pérez	2
Verhoeff	34	Weiss	2
A. Aichhorn	32	Bothy	1
P.F.F. Roeseler	30	Y. Braet	1
R. Benoist	16	E. Cavro	1
J. Banaszak	14	G. Delvare	1
L. Vuyck	13	Heiss	1
Gross	8	F. Schremmer	1
G. De Lattin	7	Tixador	1
Glatz	7	J. Vachal	1
H. Marion	7	*unknown*	771
C. Ferton	6		

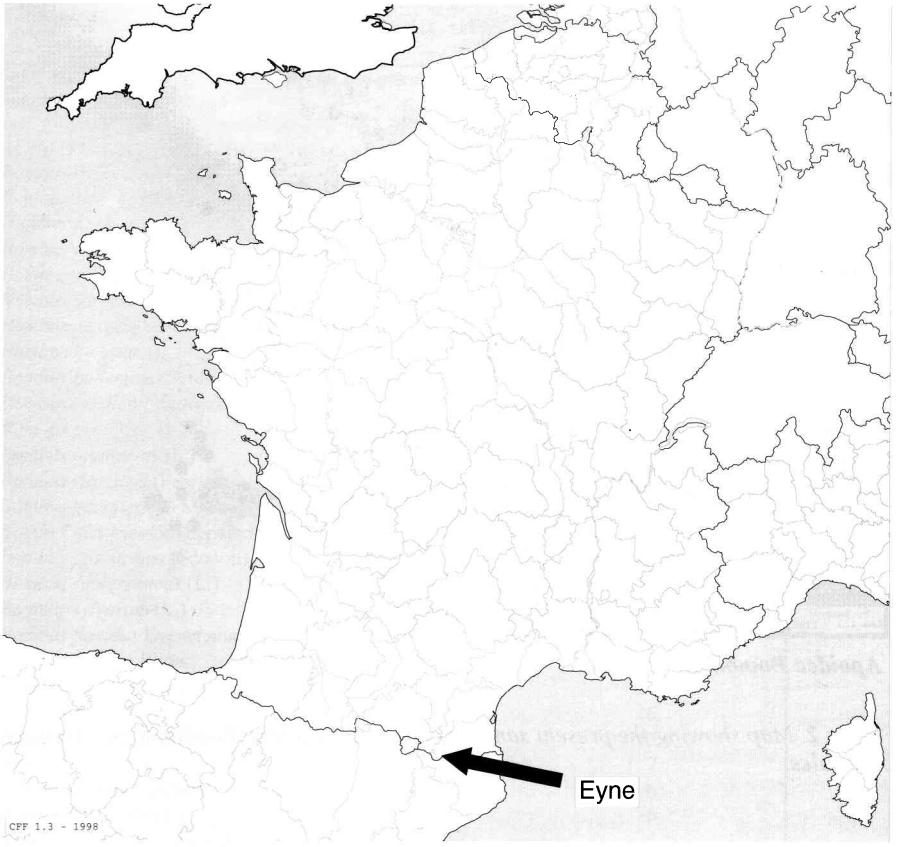

Figure 1. *Map of France and adjacent countries showing the location of Eyne (Pyrénées-Orientales, Cerdagne)*

Table II. *Main recorders of bumblebees in the commune of Eyne (Pyrénées-Orientales, Cerdagne)*

Recorder	specimens numbers
R. DELMAS	1182
F. LECLANT	316
P. RASMONT	297
R. BENOIST	2
J. HAMON	1
H. MARION	1
unknown	75

***Figure 2**. Map showing the present sampling cover for Apoidea Bombinae in Pyrénées-Orientales*

Most observations in Eyne have been made by the late Prof. Robert Delmas (most results having been presented in Delmas, 1976), Prof. François Leclant and the first author (Tab. II). Few data are available in literature, mainly in Kruseman (1958), Delmas (1976) and Rasmont (1988).

The data are managed by the Banque de Données Fauniques de Gembloux et Mons (Profs C. Gaspar & P. Rasmont) with the software Data Fauna Flora (Barbier et al., 1999). The maps are made with Carto Fauna Flora (Barbier & Rasmont, 1995, 1996).

This year, the authors started a project of thorough faunistic exploration of the commune. 3027 bumblebees have been observed during the summer 1999, on more than hundred flower species. The resulting data are still being analysed.

RESULTS AND DISCUSSION

Table III. *List of the bumblebees species observed in Pyrénées-Orientales and in the commune of Eyne up to 1998*

	Pyrénées-Orientales	*Eyne*
Bombus ruderarius (Müller)	1191	337
Bombus sichelii Radoszkowski	413	132
Bombus hortorum (L.)	586	130
Bombus pyrenaeus Pérez	256	126
Bombus sylvestris (Lepeletier)	313	120
Bombus soroeensis (Fabricius)	534	119
Bombus mesomelas Gerstaecker	378	119
Bombus lucorum (L.)	550	108
Bombus bohemicus Seidl	262	85
Bombus wurflenii Radoszkowski	464	76
Bombus pratorum (L.)	407	70
Bombus lapidarius (L.)	477	53
Bombus rupestris (Fabricius)	166	50
Bombus gerstaeckeri Morawitz	151	46
Bombus quadricolor (Lepeletier)	87	42
Bombus pascuorum (Scopoli)	513	42
Bombus subterraneus (L.)	155	33
Bombus sylvarum (L.)	176	32
Bombus flavidus Eversmann	143	30
Bombus humilis Illiger	273	26
Bombus mendax Gerstaecker	87	23
Bombus mucidus Gerstaecker	162	16
Bombus monticola Smith	163	13
Bombus hypnorum (L.)	37	7
Bombus confusus Schenck	68	6
Bombus terrestris (L.)	515	6
Bombus campestris (Panzer)	62	4
Bombus (Allopsithyrus) sp.	24	3
Bombus cullumanus (Kirby)	5	3
Bombus ruderatus (Fabricius)	56	2
Bombus magnus Vogt	49	- *
Bombus muscorum (L.)	19	-
Bombus norvegicus (Sparre Schneider)	16	- *
Bombus barbutellus (Kirby)	1	-
Bombus jonellus (Kirby)	1	-
Bombus mocsaryi Kriechbaumer	1	-
Nombre total de spécimens :	8761	1859
Nombre total d'espèces :	36	30 (32*)

* New observations made by the authors in the summer 1999.

As much as 32 different bumblebees species have been observed in the Eyne commune (Tab. III).

Pekkarinen & Teräs (1993), reviewing the places of maximal diversity in the West-Palaearctic region, mentions no other place where 32 species can be found on an area as small as 2000 ha.

For the rest of the World, many places remain insufficiently explored. Two other regions, however, are well known for the diversity of their bumblebees fauna: western Himalayas (Williams, 1991) and California (Thorp *et al.* 1983) stay below the species riches of the Eyne district.

In the Erzurum region of Turkey, Özbek (1990) lists 30 species. This district, however, is much larger than the Eyne commune ; in extent, it compares to the whole region of Cerdagne, where 36 species can be found. In the present state of our knowledge, the region of Eyne may be considered as holding the highest bumblebees diversity.

The most abundant species in Eyne are: *Bombus ruderarius, B. sicheli, B. hortorum, B. pyrenaeus, B. sylvestris, B. soroeensis, B. mesomelas* and *B. lucorum* (Tab. III).

Noteworthy is the presence of *B. gestaeckeri, B. cullumanus* and *B. confusus*, which are most uncommon elsewhere.

Among the species from Eyne, we find a large diversity of eco-geographical preferences. Some species are subalpine; others are mountain or hill species : this is obviously consistent with the wide altitude range of the district : from 1,400 to 2,900 m. Some species, as *B. hypnorum* are forest dwellers, or borderline species, as *B. sylvarum*, or open field ones, as *B. confusus*. Here again, this is easily explained by the diversity of vegetation types in the region. Many species are strongly polylectic (*pascuorum, pratorum*) but some, as *B. gerstaeckeri* and *B. wurflenii* are strict specialists.

From a biogeographical point of view, we find Atlantic species (*B. magnus, B. cullumanus*), mid-European ones: (*B. confusus*), Euro-Mediterranean ones: (*B. terrestris, B. lapidarius*), Euro-Siberian ones : (*B. lucorum, B. pratorum*), as well as montane species (*B. mesomelas, B. mucidus*) and the boreo-alpine *B. monticola.* This aspect of the local diversity may be ascribed to the geographical location of the Cerdagne, open to a variety of influences.

From the phylogenetic point of view, it may be stressed that of the 22 subgenera of the West-Palaearctic region, 19 can be found in Eyne, though without a single endemic species. The local diversity cannot be explained as a mere pre-glacial relict.

The particular situation of Eyne, with its large ecological and biogeographical diversity may partly explain the diversity of its bumblebees fauna. However, the same factors may be present in other places through Europe, without resulting in the same effects. Other factors should therefore be looked for.

The species diversity in Eyne is in clear contradiction with Inouye's theory : there are well over four species in the commune, as well as in any of its biotopes.

The Hanski theory does not fare better: there is no clear-cut distinction between core and satellite species, and well over four species account, each, for more than 3 % of the total population. The diversity cannot be simply explained by a sharing of ecological and nutritional resources.

Ranta & Vepsäläinen (1981) explain the great diversity of the northern bumblebees faunas by the frequent occurrence of "catastrophic environmental vicissitudes". These may randomly restrict the populations to levels below the competition threshold, allowing a great diversity of small populations — and species — to coexist. This explanation is appealing in the case of Eyne. Indeed, the Pyreneans are well known for their climatic instability. The weather may turn from torrid to ice-cold within the same day, with temperature differences of 30° C. and almost daily thunderstorms. Such harsh conditions can be expected to impose a heavy toll on bumblebees populations and make for the kind of situation described by Ranta & Vepsäläinen.

There is one difference, however, between the taiga and tundra biotopes described by these authors and the Eyne region. The very abundant and varied vegetation of the Pyreneans may have allowed the coexistence of many species, with a very low level of interspecific competition.

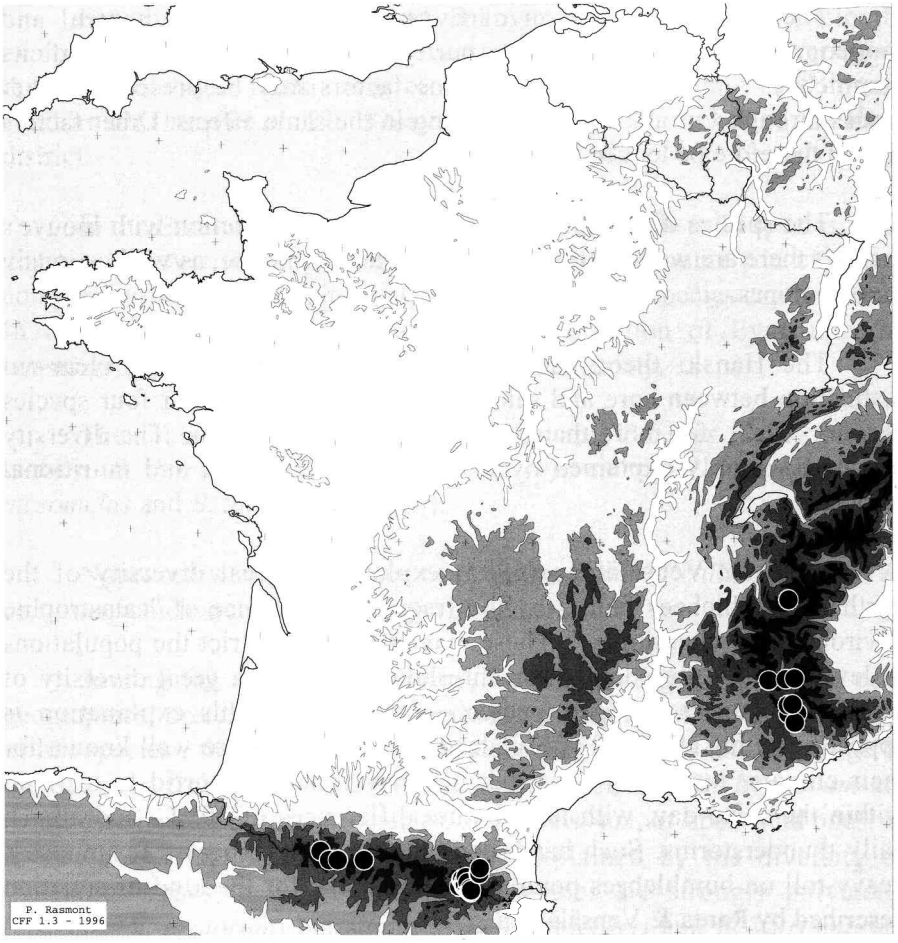

***Figure 3**. Distribution of Bombus gerstaeckeri Morawitz in France*

The case of *Bombus gerstaeckeri* is a special one. This species is a strict specialist : it is found almost exclusively on *Aconitum vulparia*. It lives in the subalpine stages and its distribution is very narrow. In W Europe, close to 90 % of the recent observations concentrate in three regions : the High Pyrénées, the eastern Pyrénées and the Alpes-Maritimes (Fig. 3). More than half of the observations have been made in two localities of the Pyrénées Orientales: the Eyne valley and the nearby Madres massif. This species may be one of the more narrowly localised in Europe.

Our current research program may shed some more light on the questions raised here, and confirm — or invalidate — some of our hypotheses. Whatever the prospect, we'll keep marvelling at the amazing diversity of the bumblebees fauna in Eyne.

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